# C.2.4 LOWER COLUMBIA RIVER COHO SALMON

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## C.2.4.1 Summary of Previous BRT Conclusions

The status of Lower Columbia River coho salmon was initially reviewed by the National Marine Fisheries Service (NMFS) in 1996 (NMFS 1996b) and the most recent review occur in 2001 (NMFS 2001a). In the 2001 review, the Biological Review Team (BRT) was very concerned that the vast majority (over 90%) of the historical populations in the Lower Columbia River coho salmon ESU appear to be either extirpated or nearly so. The two populations with any significant production (Sandy and Clackamas) were at appreciable risk because of low abundance, declining trends and failure to respond after a dramatic reduction in harvest. The large number of hatchery coho salmon in the ESU was also considered an important risk factor. The majority of the 2001 BRT votes were for "at risk of extinction" with a substantial minority in "likely to become endangered."

**Current Listing Status—**candidate species

## C.2.4.2 New Data and Updated Analyses

New data include spawner abundance estimates through 2002 for Clackamas and Sandy populations (the previous status review had data just through 1999). In addition, the Oregon Department of Fish and Wildlife (ODFW) conducted surveys of Oregon Lower Columbia River coho salmon using a stratified random sampling design in 2002, which provided the first abundance estimates for lower tributary populations (previously only limited index surveys were available. Estimates of the fraction of hatchery-origin spawners accompany the new abundance estimates. In Washington, no surveys of natural-origin adult coho salmon abundance are conducted. Updated information through 2002 on natural-origin smolt production from Cedar, Mill, Germany, and Abernathy creeks and the upper Cowlitz River were provided by the Washington Department of Fish and Wildlife (WDFW).

New analyses include the tentative designation of demographically independent populations, the recalculation of metrics reviewed by previous BRTs with additional years of data, estimates of median annual growth rate ($\lambda$) under different assumptions about the reproductive success of hatchery fish, a new stock assessment of Clackamas River coho by ODFW (Zhou and Chilcote 2003), and estimates of current and historically available kilometers of stream.

**Historical population structure—**As part of its effort to develop viability criteria for Lower Columbia River salmon and steelhead, the Willamette/Lower Columbia Technical Recovery Team (WLC-TRT) has identified historically demographically independent populations of Endangered Species Act-listed salmon and steelhead in the Lower Columbia River (Myers et al. 2002). Population boundaries are based on an application of Viable Salmonid Populations definition (McElhany et al. 2000). Based on the WLC-TRT's framework for chinook and steelhead, the BRT tentatively designated populations of Lower Columbia River coho salmon (Figure C.2.4.1). A working group at the Northwest Fisheries Science Center hypothesized that the Lower Columbia River coho salmon ESU historically consisted of 23 populations. These population designations have not yet been reviewed by the WLC-TRT. With the exception of the Clackamas coho, the populations shown in Figure C.2.4.1 are used as the units for the new analyses in this report.

Previous BRT and ODFW analyses have treated the coho in the Clackamas River as a single population (see previous status review updates for more complete discussion and references). However, recent analysis by ODFW (Zhou and Chilcote 2003) supports the hypothesis that coho salmon in the Clackamas River consist of two populations, an early run and a late run. The late run population is believed to be descendant of the native Clackamas River population, and the early run is believed to descend from hatchery fish introduced from Columbia River populations outside the Clackamas River basin. There is uncertainty about the population structure of Clackamas River coho; therefore, in this report, analyses on Clackamas River coho are conducted under both the single population and two population hypotheses for comparison.

For other salmonid species, the WLC-TRT partitioned Lower Columbia River populations into a number of "strata" based on major life-history characteristics and ecological zones (McElhany et al. 2003). These analyses suggest that a viable ESU would require a number of viable populations in each of these strata. Coho salmon do not have the major life-history variation seen in Lower Columbia River steelhead or chinook, and would thus be divided into strata based only on ecological zones. The strata and associated populations for coho salmon are identified in Table C.2.4.1.

## Abundance and trends

Recent abundance of natural-origin spawners, and recent fraction of hatchery-origin spawners for Lower Columbia River coho salmon populations are summarized in Table C.2.4.1. Natural-origin fish are defined as those whose parents that spawned in the wild, while hatchery-origin fish are defined as those whose parents were spawned in a hatchery. Some populations (e.g. North Fork Lewis River) are above impassible barriers and are completely extirpated. Most of the other populations, except for the Clackamas and Sandy Rivers are believed to have very little, if any, natural production. References for abundance time series and related data are in Appendix C.5.2.

**Clackamas—**The Clackamas River population above the North Fork Dam is one of only two populations in the ESU for which natural production trends can be estimated. The portion of the population above the dam has a relatively low fraction of hatchery-origin spawners, while the area below the dam is dominated by hatchery-origin spawners (Table C.2.4.1). The recent average number of coho salmon above the dam is shown in Table C.2.4.2, and counts of total adults and natural-origin adults passing the North Fork dam is shown in Figure C.2.4.2. Prior to 1973, hatchery-origin adults and juveniles were released above North Fork Dam, and the time series from 1957-1972 contains an unknown fraction of hatchery-origin spawners. Since almost all Lower Columbia River coho salmon females and most males spawn at 3 years of age, a strong cohort structure is produced. Figure C.2.4.3 shows the three adult cohorts on the Clackamas. As discussed in the section on population structure, multiple hypotheses exist regarding the number of historical and current populations in the Clackamas basin. Zhou and Chilcote (2003) partitioned current Clackamas River coho above North Fork into two populations (Figure C.2.4.4). Figure C.2.4.5 shows the number of juvenile coho outmigrants passing the North Fork Dam from 1957-2002.

Table C.2.4.1. Recent abundance of natural-origin spawners and recent fraction of hatchery-origin spawners for Lower Columbia River coho salmon populations. The ecological zones are based on ecological community and hydrodynamic patterns. Abundance and hatchery fraction are based on ODFW and Portland General Electric (PGE) data. ND - no data available.

| **Ecological Zone** | **Putative Population** | **2002 Total Spawners** | **2002 Hatchery Fraction (%)** | **2002 Natural-origin Smolts** |
|---|---|---|---|---|
| Coastal | Youngs Bay | 4,473 (combined Youngs bay and Big Creek) | 91 | ND |
| | Big Creek | | | ND |
| | Grays River | ND | ND | ND |
| | Elochoman | ND | ND | ND |
| | Clatskanie | 229 | 60 | ND |
| | Mill, Germany, Abernathy | ND | ND | 22,700 |
| | Scappoose | 458 | 0 | ND |
| Cascade | Cispus | ND | ND | 168,281 |
| | Tilton | ND | ND | |
| | Upper Cowlitz | ND | ND | |
| | Lower Cowlitz | ND | ND | ND |
| | North Fork Toutle | ND | ND | ND |
| | South Fork Toutle | ND | ND | ND |
| | Coweeman | ND | ND | ND |
| | Kalama | ND | ND | ND |
| | North Fork Lewis | ND | ND | 32,695 (Cedar Creek only) |
| | East Fork Lewis | ND | ND | ND |
| | Clackamas | 1,001 (above North Fork)<br>2,402 (below North Fork) | 12 (above N. Fork)<br>78 (below N. Fork) | ND |
| | Salmon Creek | ND | | ND |
| | Sandy | 310 (above Marmont)<br>271 (below Marmot) | 0 (above Marmot)<br>97 (below Marmot) | ND |
| | Washougal | ND | ND | ND |
| Gorge | Lower Gorge Tributaries | ND | ND | ND |
| | White Salmon | ND | ND | ND |
| | Upper Gorge Tributaries | 1,317 (Combined Hood River and Oregon only upper gorge ) | >65* | ND |
| | Hood River | | | ND |

*Contain an unknown (i.e. unmarked) additional fraction of hatchery-origin coho from upstream releases.

Table C.2.4.2. Recent abundance estimates for subset of Lower Columbia coho populations.

| Population | | Years for Recent Means | Recent Geometric Mean | Recent Arithmetic Mean |
|---|---|---|---|---|
| Clackamas (above North Fork Dam) | Total | 2000 – 2002 | 2,122 | 2,453 |
| | Early Run | 1996-1999 | 302 | 531 |
| | Late Run | 1996-1999 | 35 | 100 |
| Sandy (above Marmot Dam) | | 2000 – 2002 | 643 | 739 |

The long-term trends and growth rate (λ) estimates over the entire time series for the total count at North Fork Dam and the early run portion have been slightly positive and the short-term trends and λ have been slightly negative (Tables C.2.4.3 and C.2.4.4).

Table C.2.4.3. Long-term trend and growth rate for subset of Lower Columbia coho salmon populations (95% C.I. are in parentheses). The long-term analysis used the entire data set (see Table C.2.4.2 for years). The λ calculation estimates the natural growth rate after accounting for hatchery-origin spawners. Since the fraction of hatchery-origin spawners prior to 1973 in the Clackamas River is unknown, λ estimates for the Clackamas River use data from 1973 onward. The λ estimate is calculated under two hypotheses about the reproductive success of hatchery-origin spawners: Hatchery = 0 - hatchery fish are assumed to have zero reproductive success; Hatchery = Wild - hatchery fish are assumed to have the same reproductive success as natural-origin fish.

| Population | | Years for Trend | Trend of Total Spawners | Years for λ | Median Growth Rate (λ) | |
|---|---|---|---|---|---|---|
| | | | | | Hatchery = 0 | Hatchery = Wild |
| Clackamas (above North Fork Dam) | Total | 1957 – 2002 | 1.009 (0.994 – 1.024) | 1973 – 2002 | 1.028 (0.898 – 1.177) | 1.026 (0.897 – 1.174) |
| | Early Run | 1973 – 1998 | 1.080 (1.015 – 1.149) | 1973 – 1998 | 1.085 (0.944 – 1.248) | 1.085 (0.944 – 1.248) |
| | Late Run | 1973 – 1998 | 0.926 (0.863 – 0.993) | 1973 – 1998 | 0.958 (0.834 – 1.102) | 0.958 (0.834 – 1.102) |
| Sandy | | 1977 – 2002 | 0.997 (0.941 – 1.056) | 1977 – 2002 | 1.012 (0.874 – 1.172) | 1.012 (0.874 – 1.172) |

Table C.2.4.4. Short-term trend and growth rate for subset of Lower Columbia coho populations (95% C.I. are in parentheses). Short-term data sets include data from 1990 to the most recent available year. The λ calculation estimates the natural growth rate after accounting for hatchery-origin spawners. The λ estimate is calculated under two hypotheses about the reproductive success of hatchery-origin spawners: Hatchery = 0 - hatchery fish are assumed to have zero reproductive success; Hatchery = Wild - hatchery fish are assumed to have the same reproductive success as natural-origin fish.

| Population | | Years for Trend | Trend of Total Spawners | Years for λ | Median Growth Rate (λ) | |
|---|---|---|---|---|---|---|
| | | | | | Hatchery = 0 | Hatchery = Wild |
| Clackamas (above North Fork Dam) | Total | 1990 – 2002 | 0.949 (0.832 – 1.083) | 1990 – 2002 | 0.975 (0.852 – 1.116) | 0.970 (0.848 – 1.110) |
| | Early Run | 1990 – 1998 | 0.884 (0.601 – 1.302) | 1990 – 1998 | 0.902 (0.785 – 1.037) | 0.902 (0.785 – 1.037) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Late Run | 1990 – 1998 | 0.734 (0.406 – 1.325) | 1990 – 1998 | 0.843 (0.734 – 0.969) | 0.843 (0.734 – 0.969) |
| Sandy | | 1990 – 2002 | 0.964 (0.841 – 1.105) | 1977 – 2002 | 0.979 (0.845 – 1.133) | 0.978 (0.845 – 1.132) |

The late run portion of the North Fork Dam count (hypothesized to be the remains of the historical Clackamas River coho population) shows negative trends and growth rates over both the long and short term. However, the confidence intervals on trend and growth rate are large, so there is a great deal of uncertainty. Both the long-term and short-term trends and λ have relatively high probabilities of being less than one (Tables C.2.4.5 and C.2.4.6).

Table C.2.4.5. Probability that the long-term abundance trend or growth rate of Lower Columbia River coho salmon is less than one: Hatchery = 0 - hatchery fish are assumed to have zero reproductive success; Hatchery = Wild - hatchery fish are assumed to have the same reproductive success as natural-origin fish.

| **Population** | | **Years for Trend** | **Prob. Trend <1** | **Years for λ** | **Prob. λ < 1** | |
|---|---|---|---|---|---|---|
| | | | | | **Hatchery = 0** | **Hatchery = Wild** |
| Clackamas (above North Fork Dam) | Total | 1957 – 2002 | 0.123 | 1973 – 2002 | 0.283 | 0.296 |
| | Early Run | 1993 – 1998 | 0.008 | 1973 – 1998 | 0.148 | 0.148 |
| | Late Run | 1973 – 1998 | 0.984 | 1973 – 1998 | 0.724 | 0.724 |
| Sandy | | 1977 – 2002 | 0.544 | 1977 – 2002 | 0.426 | 0.427 |

Table C.2.4.6. Probability that the short-term abundance trend or growth rate of Lower Columbia River coho salmon is less than one: Hatchery = 0 - hatchery fish are assumed to have zero reproductive success; Hatchery = Wild - hatchery fish are assumed to have the same reproductive success as natural-origin fish.

| **Population** | | **Years for Trend** | **Prob. Trend <1** | **Years for λ** | **Prob. λ < 1** | |
|---|---|---|---|---|---|---|
| | | | | | **Hatchery = 0** | **Hatchery = Wild** |
| Clackamas (above North Fork Dam) | Total | 1990 – 2002 | 0.799 | 1990 – 2002 | 0.582 | 0.600 |
| | Early Run | 1990 – 1998 | 0.762 | 1990 – 1998 | 0.711 | 0.711 |
| | Late Run | 1990 – 1998 | 0.872 | 1990 – 1998 | 0.836 | 0.836 |
| Sandy | | 1990 – 2002 | 0.716 | 1990 – 2002 | 0.564 | 0.566 |

Since the late 1980s, the number of pre-harvest recruits has declined relative to the number of spawners (Figures C.2.4.6 and C.2.4.7). Despite upturns in the last 2 years, the population has had more years below replacement since 1990 than above. Thus, even with the dramatic reductions in harvest rate (Figure C.2.4.8), the population failed to respond during the

1990s because of this recruitment failure. Although the recent increases in recruitment are encouraging, the population has not regained earlier levels and is unknown if they will persist. The recent increases in recruitment are attributable in some part to increased marine survival and marine survival cannot predict with any certainty.

Based on stock assessment analysis under the assumption that the ClackamasRiver coho consist of two populations, Zhou and Chilcote (2003) concluded that the early (introduced) run had a relatively low risk of extinction, whereas the late (native) run had a relatively high risk of extinction.

**Sandy—**The Sandy River population above Marmot Dam and the Clackamas River population(s) above North Fork Dam are the only populations in the ESU for which natural production trends can be estimated. The portion of the Sandy River population above Marmot Dam has almost no hatchery-origin spawners, while the area below the dam is dominated by hatchery-origin spawners (Table C.2.4.1). The recent average number of coho salmon above Marmot Dam is shown in Table C.2.4.2. Figure C.2.4.8 shows the total adult count passing the dam, while Figure C.2.4.9 shows the three adult cohorts on the Sandy River.

The long-term and short-term trends for the counts at Marmot Dams are both slightly negative (Tables C.2.4.3 and C.2.4.4). The long-term λ is slightly positive and the short-term λ is slightly negative (Tables C.2.4.3 and C.2.4.4). However, the confidence intervals on trend and growth rate are large, so there is a great deal of uncertainty. Both the long-term and short-term trends and λ have relatively high probabilities of being less than one (Tables C.2.4.5 and C.2.4.6).

The late 1980s recruitment failure observed in the Clackamas is also present in the Sandy River population (Figures C.2.4.10 and C.2.4.11). If anything, it may be more pronounced in the Sandy River system, and overall coho salmon abundance levels are lower. Again, despite reductions in harvest (Figure C.2.4.12), the Sandy River coho population has failed to recover to earlier recruitment levels, despite the encouraging returns in 2000 and 2001. The 2002 return showed a decline from 2000 and 2001 abundance levels (Figure C.2.4.8).

## Other Oregon populations

ODFW initiated a large effort in 2002 to obtain abundance estimates of Lower Columbia coho salmon using a random stratified sampling protocol similar to that used to estimate abundance of Oregon coastal coho salmon. Results from this survey are presented in Table C.2.4.1. These surveys indicate that Oregon Lower Columbia River coho salmon are dominated by hatchery-origin spawners, but there are some potential pockets of natural production (e.g. Scappoose Creek). With only data for one year, it is difficult reach conclusions about the abundance of coho salmon in Oregon populations down stream of the Willamette River. Marine survival for Lower Columbia River coho salmon returning in 2002 was relatively high and the Lower Columbia River tributary counts in 2002 are likely to be higher than in low marine survival years.

Prior to 2002, ODFW conducted coho salmon spawner surveys in lower Colombia River We combined these surveys to obtain spawners-per-mile information at the scale of our population units (Figures C.2.4.13- C.2.4.16). In many years over the last two decades, these surveys have observed no natural-origin coho salmon spawners. Based on the spawners-per-mile survey data, previous assessments have concluded that coho salmon in these populations are extinct or nearly so (ODFW 1995a, NMFS 2001b).

### Washington populations

The Washington side of this ESU is also dominated by hatchery production, and there are no populations known to be naturally self-sustaining. A study by NRC (1996) indicated that 97% of 425 fish surveyed on the spawning grounds were first-generation hatchery fish. There are no estimates of spawner abundance for Washington Lower Columbia River coho salmon populations. However, WDFW has recently conducted some trapping of juvenile outmigrant coho (Table C.2.4.7). These data indicate that some natural production is occurring in the Lewis River and Mill-Germany-Abernathy Creeks populations, but there is no direct way to determine if these populations would be naturally self-sustaining in the absence of hatchery-origin spawners. WDFW suggests that juvenile outmigrant production seen in the monitored streams is typical of other Washington Lower Columbia River streams and that a fairly substantial number of natural-origin spawners may return to the Lower Columbia River each year. Preliminary calculations by WDFW suggest that the natural pre-harvest recruitment from the monitored streams alone may be 17,000 adults (assuming 4% marine survival) (Haymes 2003).

The area above Cowlitz Falls is also capable of natural outmigrant production (Table C.2.4.7). However, these populations are not considered currently self-sustaining (Rawding, pers. comm.). The upper Cowlitz River is blocked to anadromous passage by three dams. Currently, adult coho salmon (some of hatchery origin) are collected below the lower dam (Mayfield Dam) and trucked to the area above the upper dam (Cowlitz Falls Dam). There is no appreciable downstream passage through the dams, so juvenile outmigrants are collected at Cowlitz Falls Dam and trucked below Mayfield Dam. At this time, collection efficiency of outmigrating juveniles at Cowlitz Falls is so low (40-60%) that the spawners could not replace themselves (i.e. fewer adult coho salmon return from the relatively low number of outmigrants that are released below Mayfield Dam than are planted above Cowlitz Falls Dam). Thus, the populations are maintained by hatchery production (in addition to the trap and haul operation).

Table C.2.4.7: Estimates of natural coho salmon juvenile outmigrants from Washington Lower Columbia River streams. Estimates are based on expansions from smolt traps, not total census. Cedar Creek is a tributary of the North Fork Lewis River population. Mill, Germany and Abernathy Creeks are combined into a single population unit for BRT analysis. The Cowlitz River above Cowlitz Falls is partitioned into three independent populations (Upper Cowlitz, Cispus, and Tilton Rivers). The East Fork Lewis River estimate shows a range based on uncertainties about trap efficiency.

| Out-migrant Year | Cedar Creek | Mill Creek | Abernathy Creek | Germany Creek | East Fork Lewis River | Cowlitz River above Cowlitz Falls |
|---|---|---|---|---|---|---|
| 1997 | | | | | | 17,490 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1998 | 38,354 | | | | | 196,520 |
| 1999 | 27,987 | | | | | 88,788 |
| 2000 | 20,282 | | | | 4,514-9,028 | 236,960 |
| 2001 | 20,695 | 6,324 | 6,991 | 8,157 | | 796,948 |
| 2002 | 32,695 | 9,500 | 6,200 | 7,000 | | 168,281 |

# C.2.4.3 New Hatchery Information

## Hatchery production

The Lower Columbia River coho salmon ESU is dominated by hatchery production. Recent coho salmon releases in the Columbia River basin (including releases upstream of the ESU boundary) are shown in Table C.2.4.8. The total expected return of hatchery coho salmon to the Columbia basin in 2002 was over a million adults (ODFW News Release, 13 September, 2002; at the time of this report, final 2002 return data are not available).

Table C.2.4.8. Total coho salmon hatchery releases into the Columbia River basin (from DART website http://www.cqs.washington.edu/dart/hatch.html made available by the Fish Passage Center).

| Year | Hatchery Releases |
|---|---|
| 2000 | 29,902,509 |
| 2001 | 25,730,650 |
| 2002 | 20,011,742 |

## Loss of habitat from barriers

Steel and Sheer (2002) analyzed the number of stream km historically and currently available to salmon populations in the Lower Columbia River (Table C.2.4.9). Stream kilometers usable by salmon are determined based on simple gradient cut-offs and on the presence of impassable barriers. This approach overestimates the number of usable stream kilometers, as it does not take into consideration aspects of habitat quality other than gradient. However, the analysis does indicate that the number of kilometers of stream habitat currently accessible is greatly reduced from the historical condition for some populations.

Table C.2.4.9. Loss of habitat from barriers. The potential current habitat is the kilometers of stream below all currently impassible barriers between a gradient of 0.5% and 4%. The potential historical habitat is the kilometers of stream below historically impassible barriers between a gradient of 0.5% and 4%. The current-to-historical habitat ratio is the percent of the historical habitat that is currently available. This table does not consider habitat quality. The Upper Cowlitz, Cispus and Tilton habitats are listed in this analysis as currently inaccessible because volitional passage is not possible. However, a trap-and-haul reintroduction program for these populations has been initiated.

| Population | Potential Current Habitat (%) | Potential Historical Habitat (km) | Current/ Historical Habitat Ratio |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Youngs Bay | 178 | 195 | 91 |
| Grays River | 133 | 133 | 100 |
| Big Creek | 92 | 129 | 71 |
| Elochoman River | 85 | 116 | 74 |
| Clatskanie River | 159 | 159 | 100 |
| Mill, Germany, Abernathy Creeks | 117 | 123 | 96 |
| Scappoose Creek | 122 | 157 | 78 |
| Cispus River | 0 | 76 | 0 |
| Tilton River | 0 | 93 | 0 |
| Upper Cowlitz River | 4 | 276 | 1 |
| Lower Cowlitz River | 418 | 919 | 45 |
| North Fork Toutle River | 209 | 330 | 63 |
| South Fork Toutle River | 82 | 92 | 89 |
| Coweeman River | 61 | 71 | 86 |
| Kalama River | 78 | 83 | 94 |
| North Fork Lewis River | 115 | 525 | 22 |
| East Fork Lewis River | 239 | 315 | 76 |
| Clackamas River | 568 | 613 | 93 |
| Salmon Creek | 222 | 252 | 88 |
| Sandy River | 227 | 286 | 79 |
| Washougal River | 84 | 164 | 51 |
| Lower Gorge Tributaries | 34 | 35 | 99 |
| Upper Gorge Tributaries | 23 | 27 | 84 |
| White Salmon River | 0 | 71 | 0 |
| Hood River | 35 | 35 | 100 |
| Total | 3,286 | 5,272 | 62 |

## ESU summary

Based on the updated information provided in this report, the information contained in previous Lower Columbia River status reviews, and preliminary analyses by the WLC-TRT, we have tentatively identified the number of historical and currently viable populations. Only two putative populations have demonstrated appreciable levels of natural production (Clackamas River, Sandy River). There is only very limited information on the remainder of the 21 putative populations, but most were considered extirpated, or nearly so, during the low marine survival period of the 1990s (reviewed in NMFS 2001a). Recently initiated spawner surveys by ODFW and juvenile outmigrant trapping by WDFW indicate there is some natural production in the Lower Columbia River. However, the majority of populations remain dominated by hatchery-origin spawners, and there is little data to indicate they would naturally persist in the long term. Of the two populations where natural production can be evaluated, both have experienced recruitment failure over the last decade. Recent abundances of the two populations are relatively low (especially the Sandy River), placing them in a range where environmental, demographic and genetic stochacity can be significant risk factors.

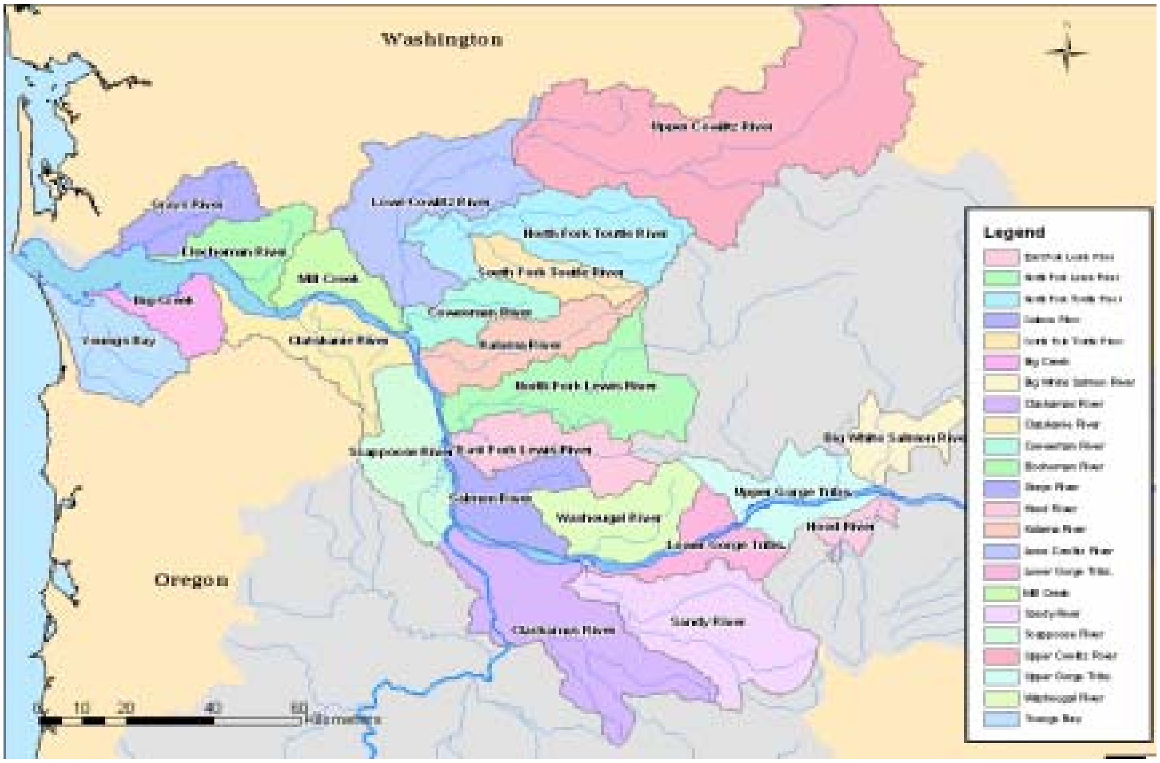


Figure C.2.4.1. Tentative historical populations of Lower Columbia River coho salmon. Based on work by WLC-TRT for chinook and steelhead (Myers et al. 2002).

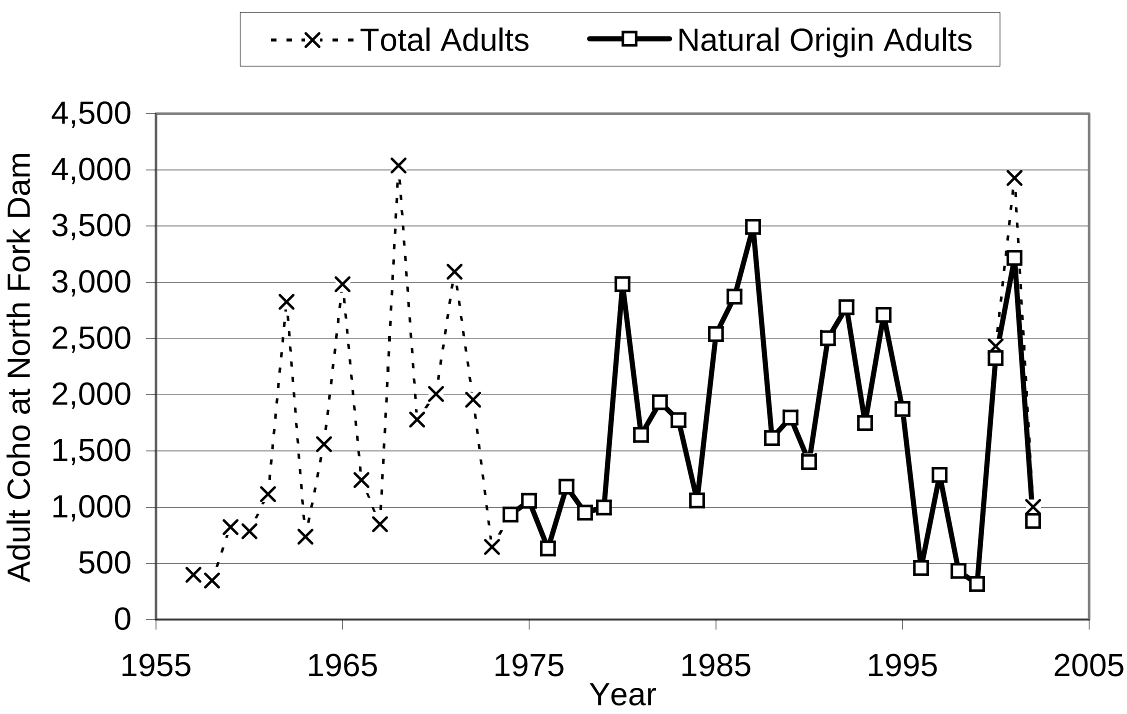


Figure C.2.4.2. Clackamas North Fork Dam counts of adult (three-year-old) coho salmon.

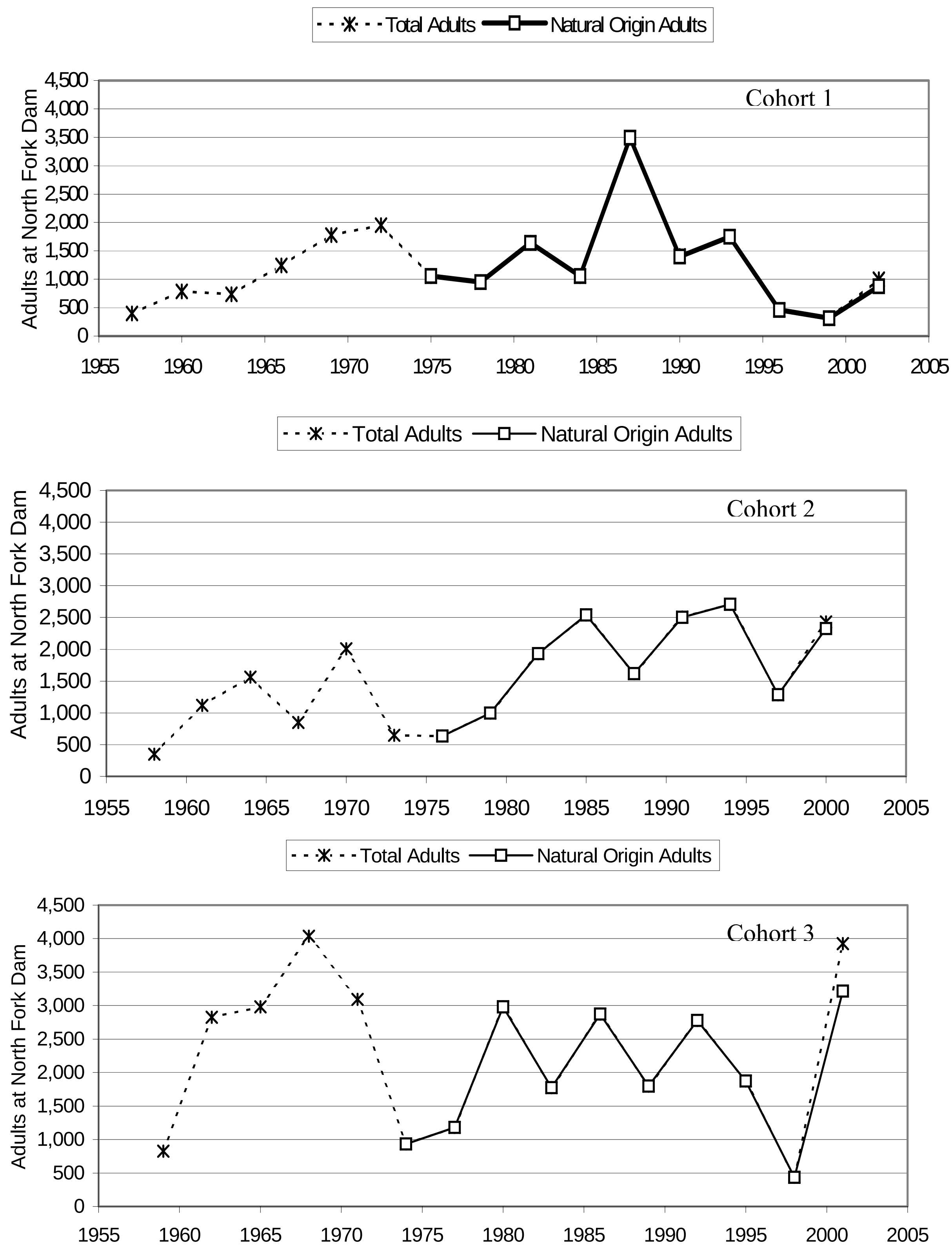


Figure C.2.4.3. Clackamas North Fork Dam counts of adult (three-year-old) coho salmon by cohort.

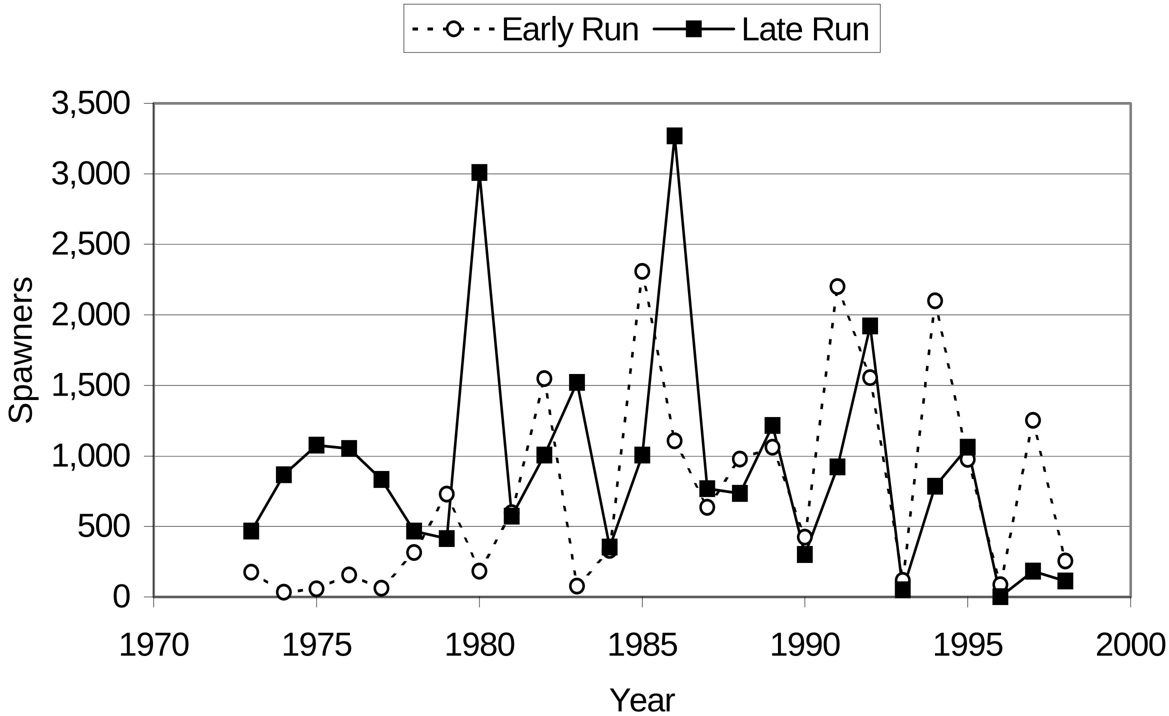


Figure C.2.4.4. Clackamas River early-run and late-run coho salmon. Run designation is based on a maximum likelihood approach assuming two populations with different mean run times (Zhou and Chilcote 2003).

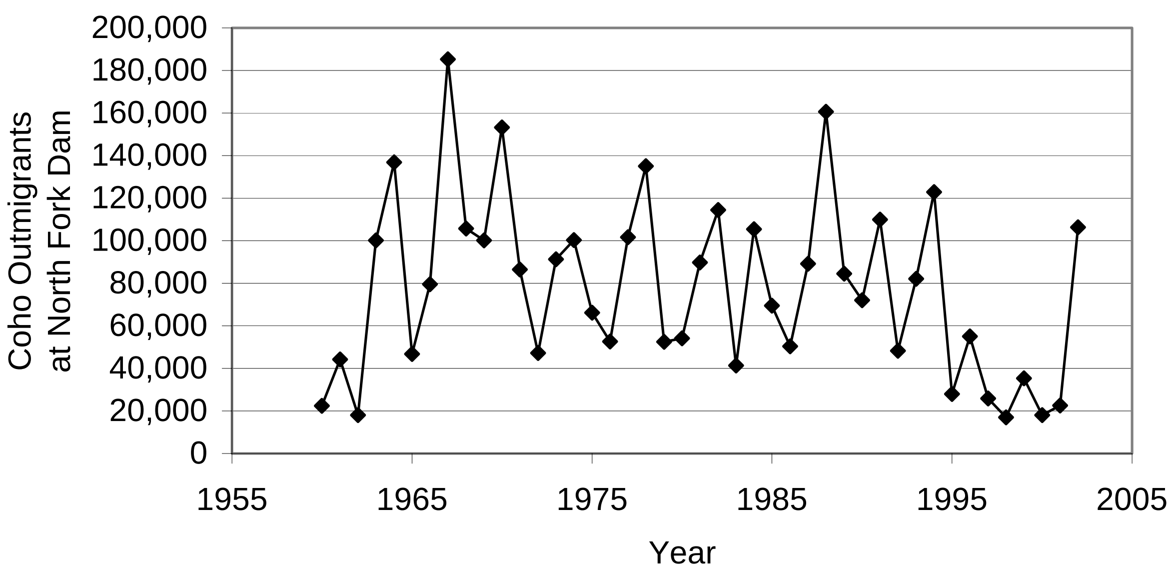


Figure C.2.4.5. Total outmigrating juvenile coho passing Clackamas North Fork Dam (Doug Cramer, pers. comm., June 5, 2003).

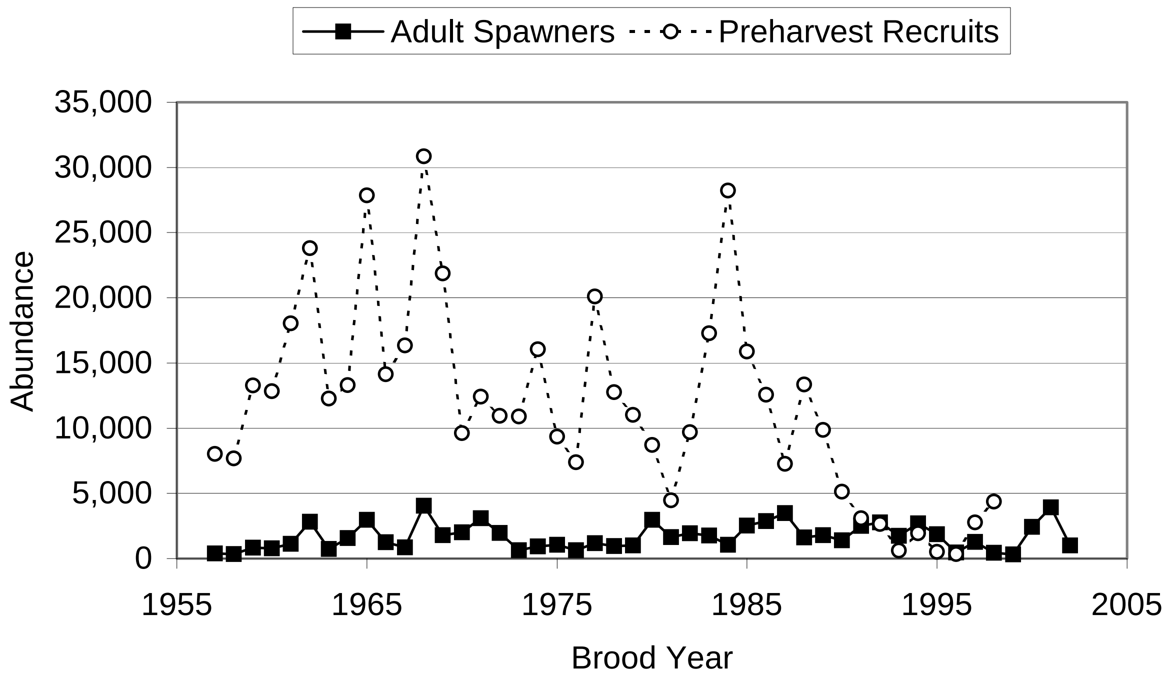


Figure C.2.4.5. Estimate of pre-harvest coho salmon recruits and spawners in the Clackamas River. Based on adult counts at North Fork Dam.

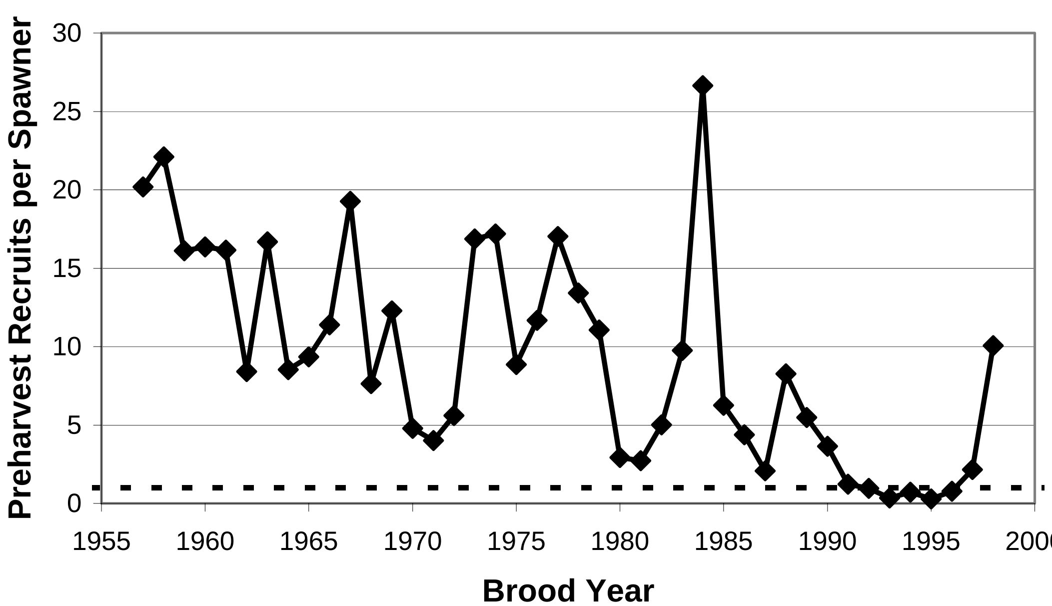


Figure C.2.4.6. Estimate of pre-harvest coho salmon recruits-per-spawner in the Clackamas River. Based on adult counts at North Fork Dam. The dashed line indicates the replacement level.

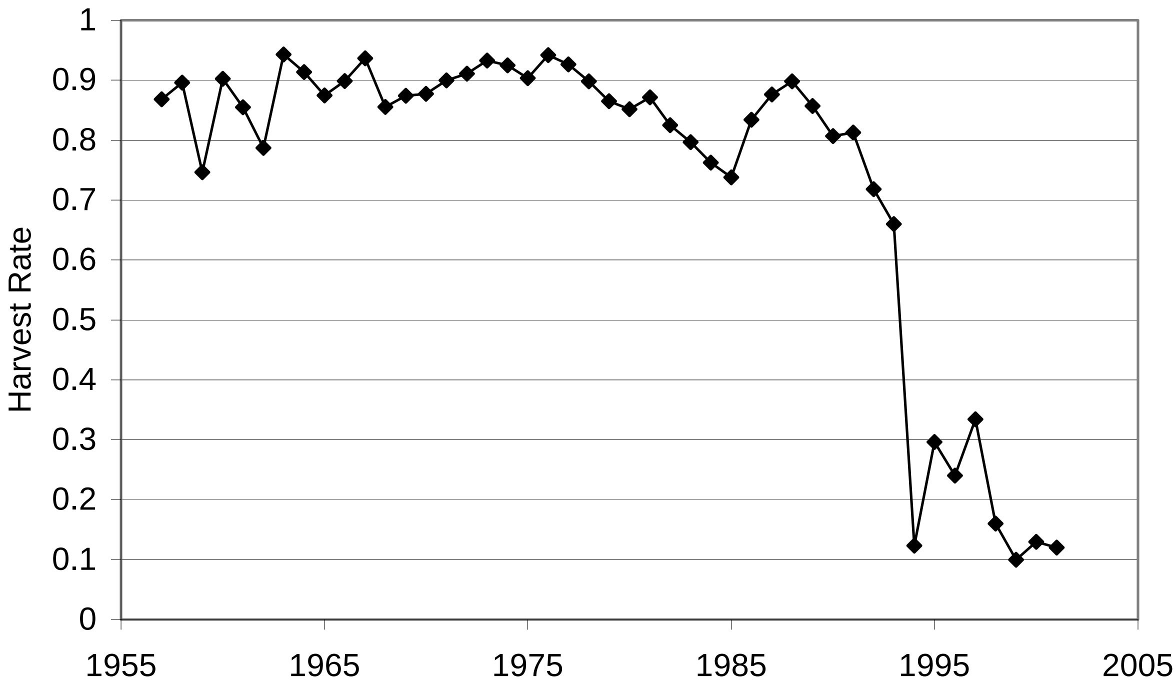


Figure C.2.4.7. Clackamas River natural-origin coho salmon harvest rate (M. Chilcote, pers. comm.). The reduction in harvest rate was achieved by a switch to retention-only marked hatchery fish and timing the fishery to protect natural runs.

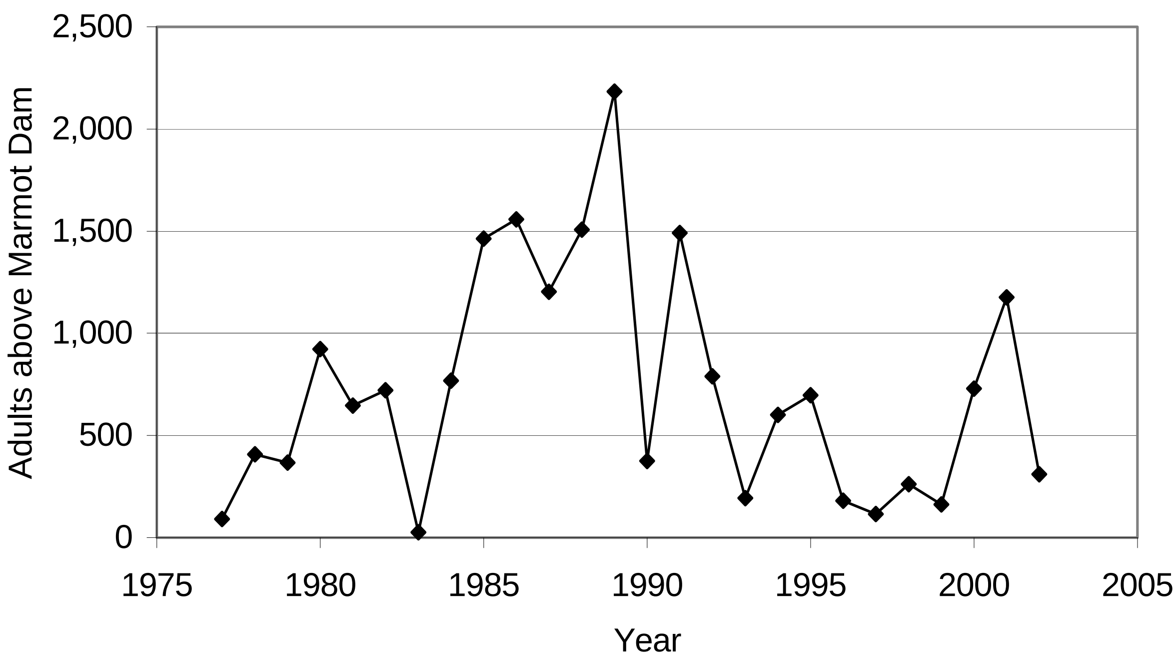


Figure C.2.4.8. Count of adult (≥3 years old) coho salmon at the Marmot Dam on the Sandy River. Almost all spawners above Marmot Dam are natural origin. For no year is the proportion of hatchery-origin spawners estimated to be greater than 2.5%.

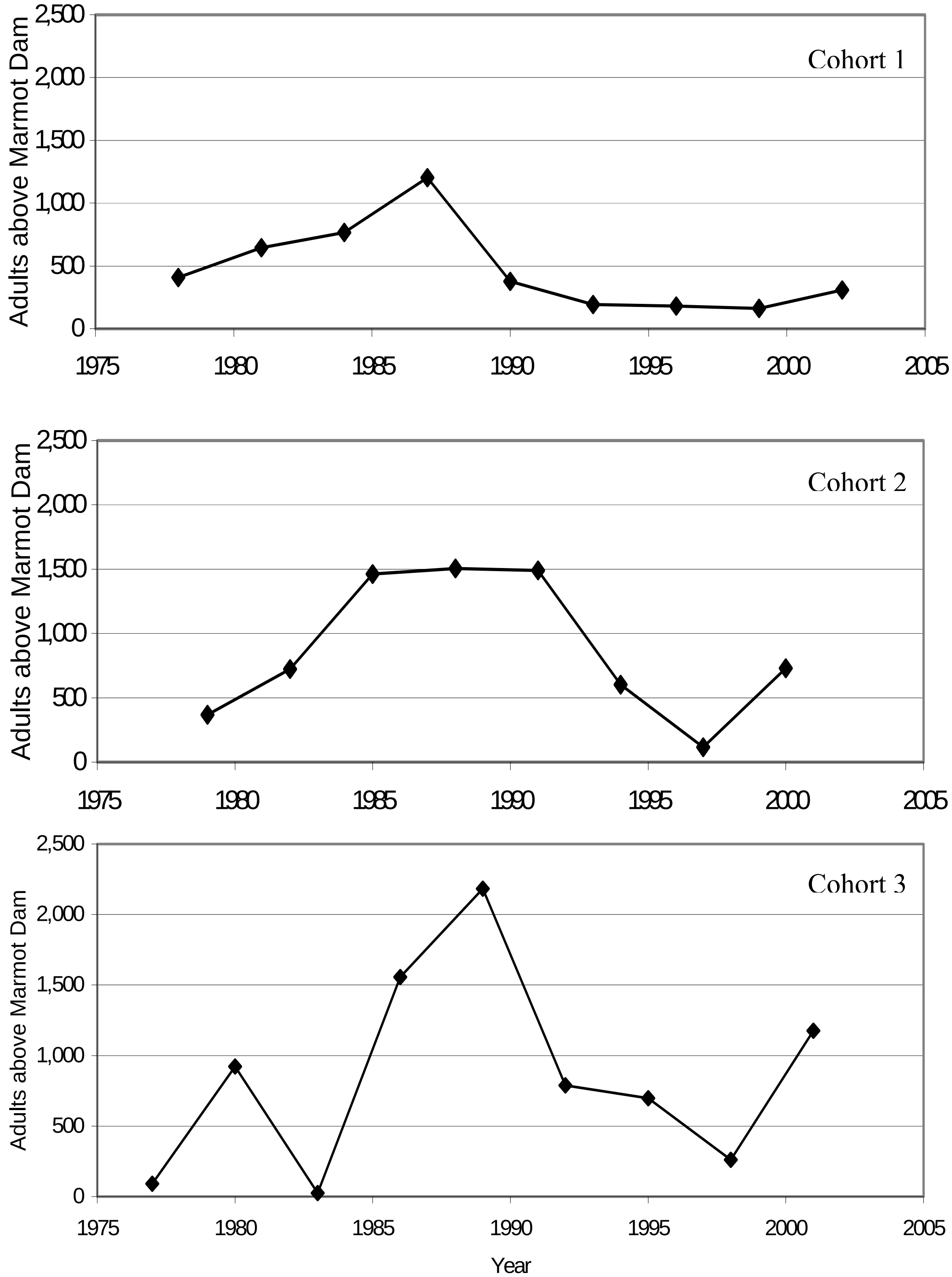


Figure C.2.4.9. Count of adult (≥3 years old) coho salmon at the Marmot Dam on the Sandy River by cohort. Almost all spawners above Marmot Dam are natural origin. For no year is the proportion of hatchery-origin spawners estimated to be greater than 2.5%.

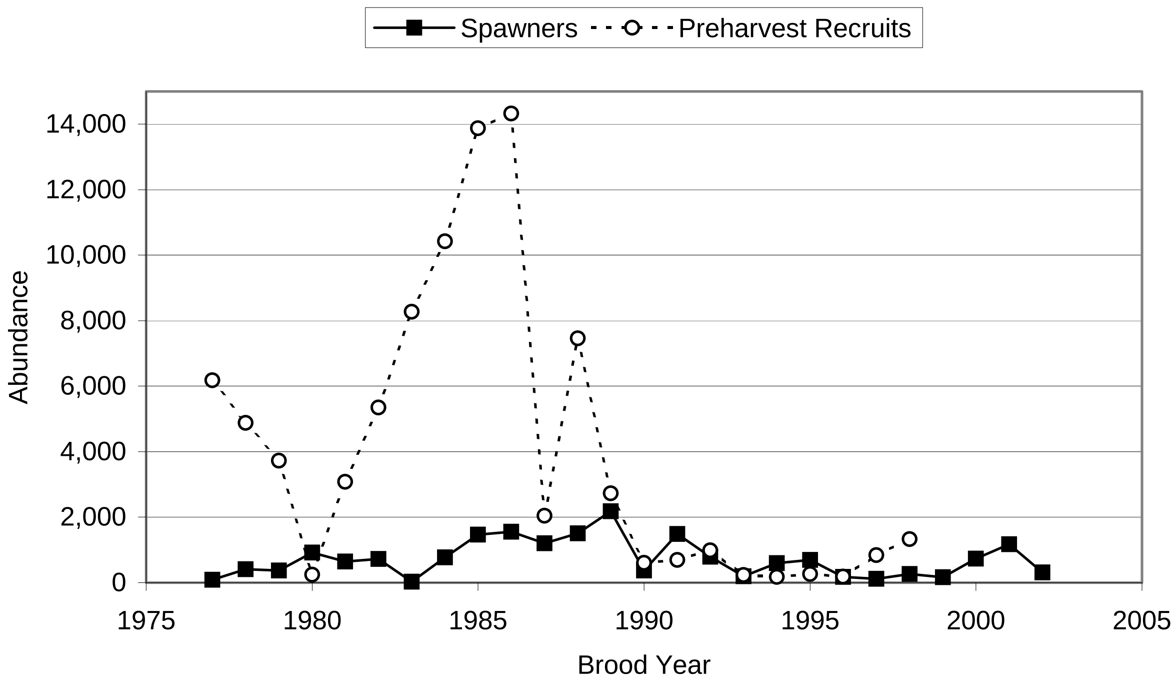


Figure C.2.4.10. Estimate of pre-harvest coho salmon recruits and spawners in the Sandy River. Based on adult counts at Marmot Dam.

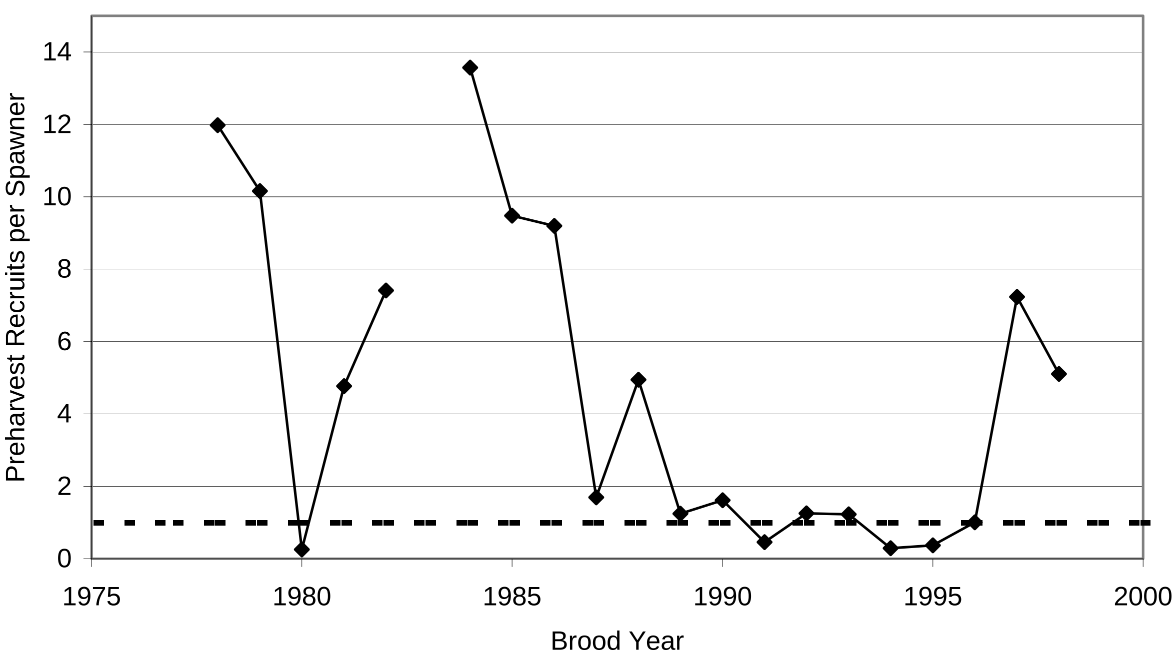


Figure C.2.4.11. Estimate of pre-harvest coho salmon recruits-per-spawners in the Sandy River. Based on adult counts at Marmot Dam. The dashed line indicates the replacement level. The 1977 brood-year pre-harvest recruits-per-spawner estimate is 68 and the 1983 brood-year estimate is 318.

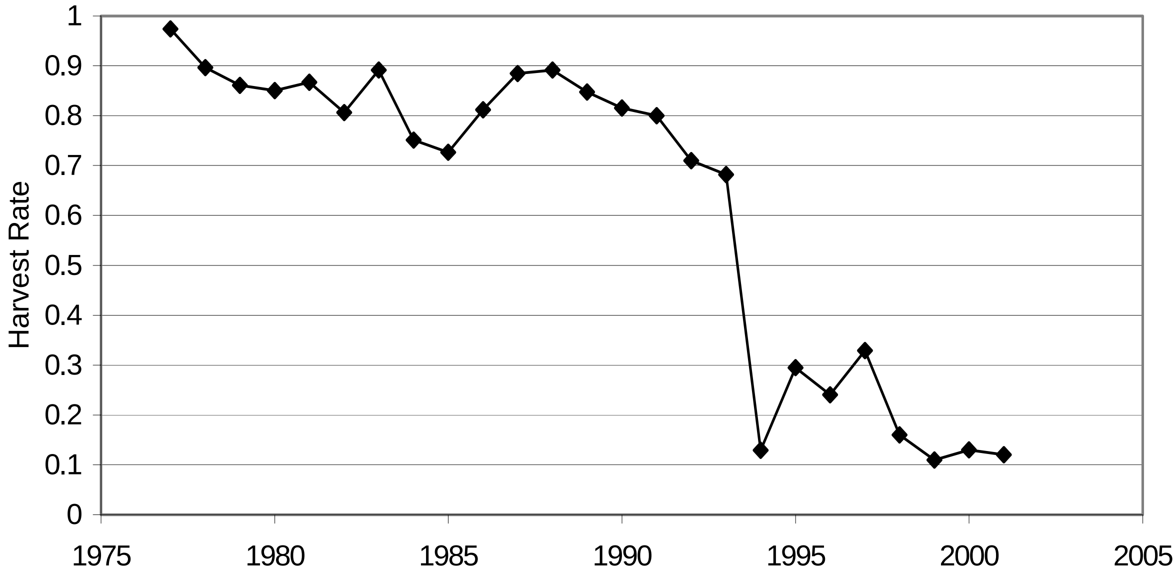


Figure C.2.4.12. Sandy River natural-origin coho salmon harvest rate (M. Chilcote, pers. comm.). The reduction in harvest rate was achieved by switch to retention only marked hatchery fish and timing the fishery to protect natural runs.

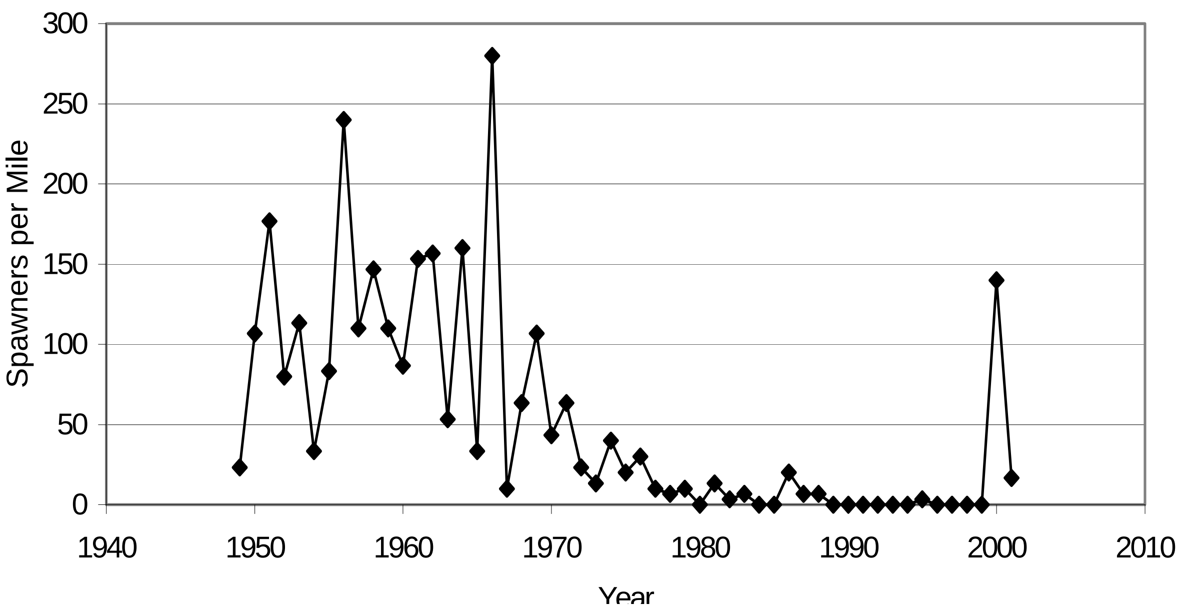


Figure C.2.4.13. Youngs Bay coho salmon spawners-per-mile.

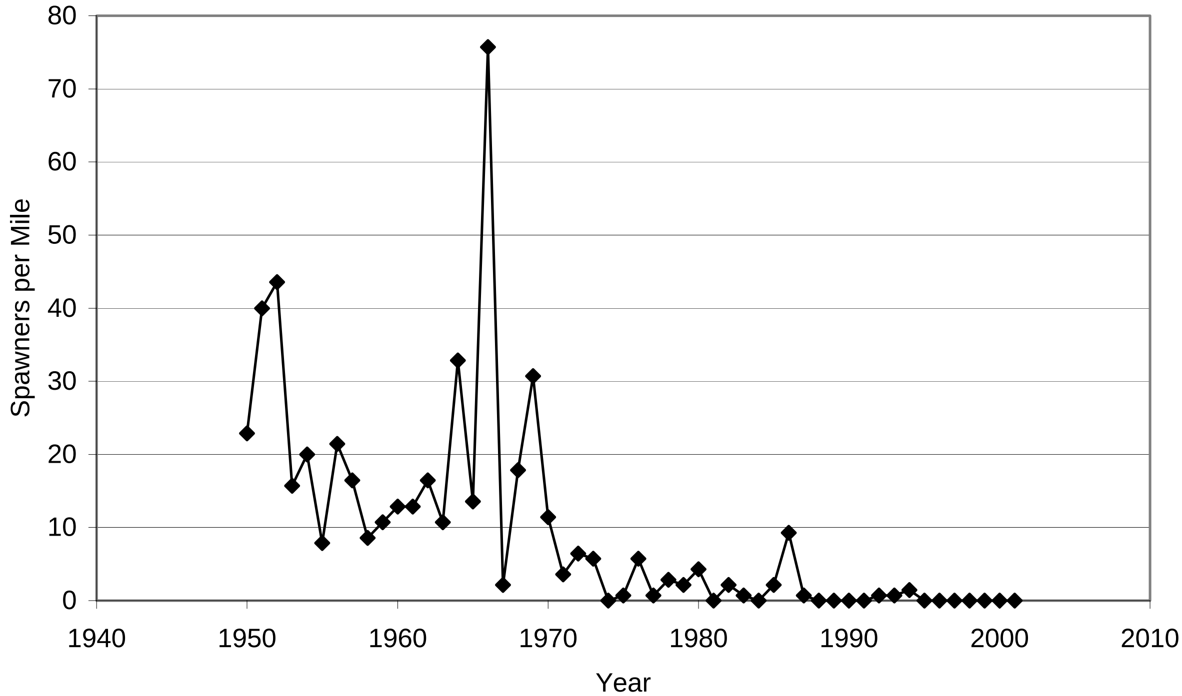


Figure C.2.4.14. Big Creek coho salmon spawners-per-mile.

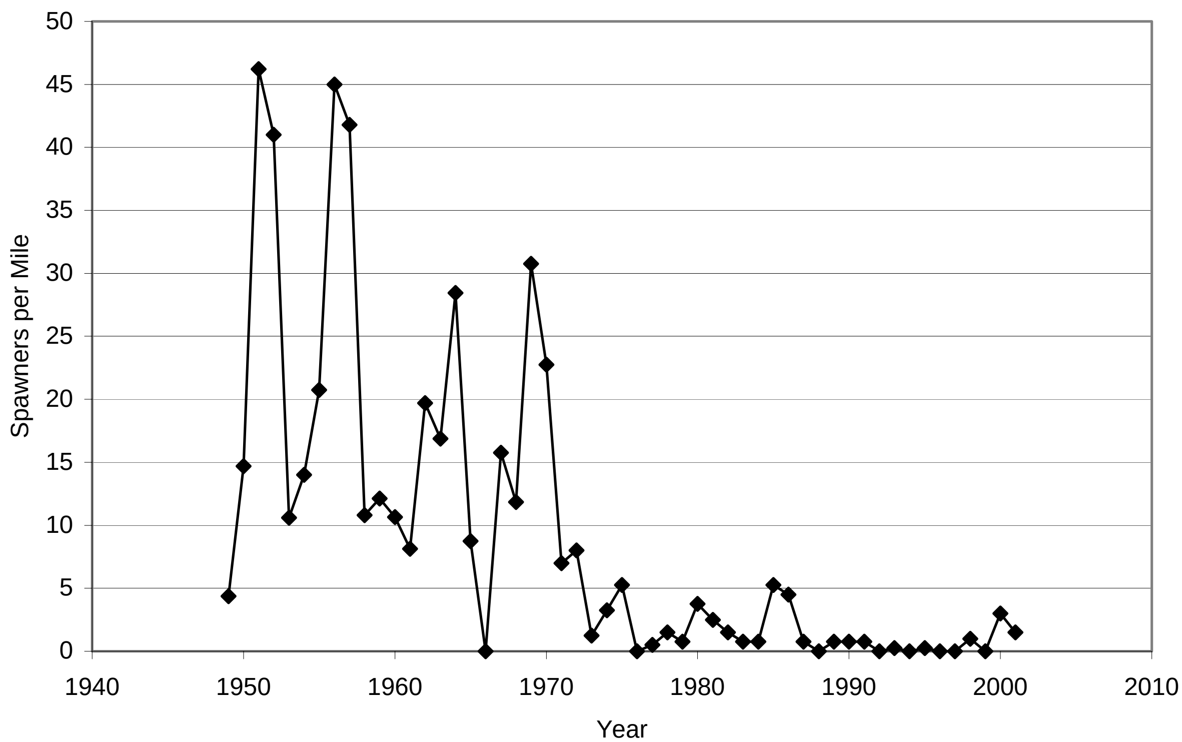


Figure C.2.4.15. Clatskanie River coho salmon spawners-per-mile.

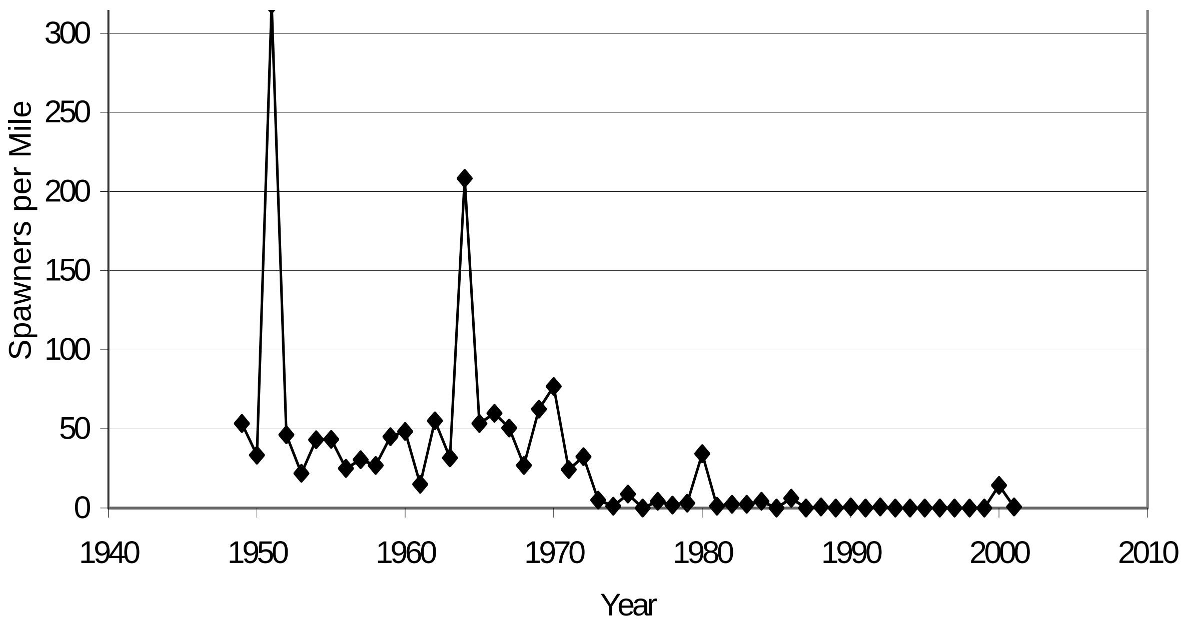


Figure C.2.4.16. Scappoose River spawners-per-mile.

# C.3 COHO SALMON BRT CONCLUSIONS

## Oregon Coast coho salmon ESU

This ESU continues to present challenges to those assessing extinction risk. The BRT found several positive features compared to the previous assessment in 1997. Adult spawners for the ESU in 2001 and 2002 exceeded the number observed for any year in the past several decades, and pre-harvest run size rivaled some of the high values seen in the 1970s. Some notable increases in spawners have occurred in many streams in the northern part of the ESU, which was the most depressed area at the time of the last status review evaluation. Hatchery reforms have continued, and the fraction of natural spawners that are first-generation hatchery fish has been reduced in many areas compared to highs in the early to mid 1990s.

On the other hand, the recent years of good returns were preceded by three years of low spawner escapements—the result of three consecutive years of recruitment failure, in which the natural spawners did not replace themselves the next generation, even in the absence of any directed harvest. These three years of recruitment failure, which immediately followed the last status review in 1997, are the only such instances that have been observed in the entire time series of data collected for Oregon Coast coho salmon. Whereas the recent increases in spawner escapement have resulted in long-term trends in spawners that are generally positive, the long-term trends in productivity in this ESU are still strongly negative.

The BRT votes reflected ongoing concerns for the long-term health of this ESU: a majority (56%) of the FEMAT votes were cast in the “likely to become endangered” category, with a substantial minority (44%) falling in the “not likely to become endangered” category (Table C.3.1). Although the BRT considered the significantly higher returns in recent years to be encouraging, most members felt that the factors responsible for the increases were more likely to be unusually favorable marine productivity conditions than improvements in freshwater productivity. The majority of BRT members felt that to have a high degree of confidence that the ESU is healthy, high spawner escapements should be maintained for a number of years, and the freshwater habitat should demonstrate the capability of supporting high juvenile production from years of high spawner abundance. As indicated in the risk matrix results, the BRT considered the decline in productivity to be the most serious concern for this ESU (mean score 3.2; Table C.3.2). With all directed harvest for these populations already eliminated, harvest management can no longer compensate for declining productivity by reducing harvest rates. The BRT was concerned that if the long-term decline in productivity reflects deteriorating conditions in freshwater habitat, this ESU could face very serious risks of local extinctions during the next cycle of poor ocean conditions. With the cushion provided by strong returns in the last 2-3 years, the BRT had much less concern about short-term risks associated with abundance (mean score 1.9).

A minority of the BRT felt that the large number of spawners in the last few years demonstrate that this ESU is not currently at significant risk of extinction or likely to become endangered. Furthermore, these members felt that the recent years of high escapement, following closely on the heels of the years of recruitment failure, demonstrate that populations in this ESU have the resilience to bounce back from years of depressed runs.

## Southern Oregon/Northern California Coasts coho salmon ESU

A majority (67%) of BRT votes fell into the "likely to become endangered" category, while votes in the "endangered" category outnumbered those in the "not warranted" categories by 2-to-1 (Table C.3.1). The BRT found moderately high risks for abundance and growth rate/production, with mean matrix scores of 3.5 to 3.8, respectively, for these two categories. Risks to spatial structure (mean score = 3.1) and diversity (mean score = 2.8) were considered moderate by the BRT (Table C.3.2).

The BRT remained concerned about low population abundance throughout the ESU relative to historical numbers and long-term downward trends in abundance; however, the paucity of data on escapement of naturally produced spawners in most basins continued to hinder assessment of risk. A reliable time series of adult abundance is available only for the Rogue River. These data indicate that long-term (22-year) and short-term (10-year) trends in mean spawner abundance are upward in the Rogue; however, the positive trends reflect effects of reduced harvest (rather than improved freshwater conditions) since trends in pre-harvest recruits are flat. Less-reliable indices of spawner abundance in several California populations reveal no apparent trends in some populations and suggest possible continued declines in others. Additionally, the BRT considered the relatively low occupancy rates of historical coho salmon streams (between 37% and 61% from broodyear 1986 to 2000) as an indication of continued low abundance in the California portion of this ESU. The relatively strong 2001 broodyear, likely the result of favorable conditions in both freshwater and marine environments, was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years.

The moderate risk matrix scores for spatial structure reflected a balancing of several factors. On the negative side was the modest percentage of historical streams still occupied by coho salmon (suggestive of local extirpations or depressed populations). The BRT also remains concerned about the possibility that losses of local populations have been masked in basins with high hatchery output, including the Trinity, Klamath, and Rogue systems. The extent to which strays from hatcheries in these systems are contributing to natural production remains uncertain; however, it is generally believed that hatchery fish and progeny of hatchery fish constitute the majority of production in the Trinity River, and may be a significant concern in parts of the Klamath and Rogue systems a well. On the positive side, extant populations can still be found in all major river basins within the ESU. Additionally, the relatively high occupancy rate of historical streams observed in broodyear 2001 suggests that much habitat remains accessible to coho salmon. The BRT's concern for the large number of hatchery fish in the Rogue, Klamath, and Trinity systems was also evident in the moderate risk rating for diversity.

## Central California coho salmon ESU

A large majority (74%) of the BRT votes fell into the "endangered" category, with the remainder falling into the "likely to become endangered" category (Table C.3.1). The BRT found CCC coho salmon to be at very high risk in three of four risk categories, with mean scores of 4.8, 4.5, and 4.7 for abundance, growth rate/productivity, and spatial structure, respectively (Table C.3.2). Scores for diversity (mean 3.6) indicated BRT members considered CCC coho salmon to be at moderate or increasing risk with respect to this risk category. Principal concerns of the BRT continue to be low abundance and long-term downward trends in abundance of coho salmon throughout the ESU, as well as extirpation or near extirpation of populations across most of the southern two-thirds of the historical range of the ESU, including several major river basins. Potential loss of genetic diversity associated with range reductions or loss of one or more brood lineages, coupled with historical influence of hatchery fish, were primary risks to diversity identified by the BRT. Improved oceanic conditions coupled with favorable stream flows apparently contributed to a strong year class in broodyear 2001, as evidenced by an increase in detected occupancy of historical streams. However, data were lacking for many river basins in the southern two-thirds of the ESU where populations are considered at greatest risk. Although viewed as a positive sign, the strong year follows more than a decade of relatively poor returns. The lack of current estimates of naturally produced spawners for any populations within the ESU—and hence the need to use primarily presence-absence information to assess risk—continues to concern the BRT.

## Lower Columbia River coho salmon ESU

The status of this ESU was reviewed by the BRT in 2000, so relatively little new information was available. A majority (68%) of the likelihood votes for Lower Columbia River coho salmon fell in the "danger of extinction" category, with the remainder falling in the "likely to become endangered" category (Table C.3.1). As indicated by the risk matrix totals (Table C.3.2), the BRT had major concerns for this ESU in all VSP risk categories (mean scores ranged from 4.2 for spatial structure/connectivity and growth rate/productivity to 4.5 for diversity). The most serious overall concern was the scarcity of naturally produced spawners throughout the ESU, with attendant risks associated with small population, loss of diversity, and fragmentation and isolation of the remaining naturally produced fish. In the only two populations with significant natural production (Sandy and Clackamas), short and long-term trends are negative and productivity (as gauged by preharvest recruits) is down sharply from recent (1980s) levels. On the positive side, adult returns in 2000 and 2001 were up noticeably in some areas, and evidence for limited natural production has been found in some areas outside the Sandy and Clackamas.

The paucity of naturally produced spawners in this ESU can be contrasted with the very large number of hatchery-produced adults. Although the scale of the hatchery programs, and the great disparity in relative numbers of hatchery and wild fish, produce many genetic and ecological threats to the natural populations, collectively these hatchery populations contain a great deal of genetic resources that might be tapped to help promote restoration of more widespread naturally spawning populations.

Table C.3.1. Tally of FEMAT vote distribution regarding the status of 4 coho salmon ESUs reviewed by the coho salmon BRT. Each of 13 BRT members allocated 10 points among the three status categories.

| ESU | Danger of Extinction | Likely to Become Endangered | Not Likely to Become Endangered |
|---|---|---|---|
| Oregon Coast | 0 | 73 | 57 |
| S. Oregon / N. California Coasts | 29 | 87 | 14 |
| Central California | 96 | 34 | 0 |
| Lower Columbia River | 88 | 42 | 0 |

Table C.3.2. Summary of risk scores (1 = low to 5 = high) for four VSP categories (see section "Factors Considered in Status Assessments" for a description of the risk categories) for the 4 coho salmon ESUs reviewed. Data presented are means (range).

| ESU | Abundance | Growth Rate/Productivity | Spatial Structure and Connectivity | Diversity |
|---|---|---|---|---|
| Oregon Coast | 1.9 (1-3) | 3.2 (2-4) | 2.3 (1-3) | 2.5 (2-3) |
| S. Oregon / N. California Coasts | 3.8 (2-5) | 3.5 (2-5) | 3.1 (2-4) | 2.8 (2-4) |
| Central California | 4.8 (4-5) | 4.5 (4-5) | 4.7 (4-5) | 3.6 (2-5) |
| Lower Columbia River | 4.4 (4-5) | 4.2 (3-5) | 4.2 (2-5) | 4.5 (4-5) |

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# C.5 APPENDICES

Appendix C.5.1. Preliminary SSHAG (2003) categorizations of hatchery populations of the four coho salmon ESUs reviewed. See “Artificial Propagation” in General Introduction for explanation of the categories.

| | Stock | Run | Basin | SSHAG Category |
|---|---|---|---|---|
| Oregon Coast | NF Nehalem | (# 32) | Nehalem | 2c |
| | Fishhawk Lake | (# 99) | Nehalem | 2a or 3a |
| | Trask River | (# 34) | Trask | 2c or 3c |
| | Siletz | (# 33) | Siletz | 2a or 3a |
| | Umpqua | (# 55) | Umpqua | 2a |
| | Cow Creek | (# 18) | Umpqua | 2a |
| | Woahink | | Siltcoos | 1a |
| | Coos | (# 37) | Coos | 2a |
| | Coquille | (# 44) | Coquille | 2a |
| S. Oregon/N. California Coasts | Rogue River | (# 52) | Rogue River | 2a |
| | Iron Gate | | Klamath | 2c |
| | Trinity River | | Trinity | 2b |
| | Mad River | | Mad River | 4 |
| Central California | Noyo River | | Noyo River | 2a |
| | Don Clausen | | Russian | 1a |
| | Monterey Bay | | Scott Creek | 1a |
| Lower Columbia River | Big Creek | | Big Creek | 2a |
| | Klaskanine | | Klaskanine | 4 |
| | Tanner Creek | | Lower Gorge | 2b |
| | Sandy River | late | Sandy | 2a |
| | Eagle Creek | | Clackamas | 2c |
| | Little White Salmon | | Upper Gorge | 3c |
| | Toutle | Type S | Cowlitz | 2a |
| | Type S Complex | Type S | various | 2c or 3c |
| | Cowlitz | Type N | Cowlitz | 2a |
| | Type N Complex | Type N | various | 2b o 2c |

Appendix C.5.2. Coho Salmon Time Series Data Sources

**Oregon Coast coho salmon ESU**

| | |
|---|---|
| Population | Oregon Coast |
| Years of Data, Length of Series | 1970-2002, 33 years |
| Abundance Type | Fish |
| Abundance References | Jacobs et al., 2000, Jacobs et al. 2001, Jacobs et al. 2002, PFMC 2002a, PFMC 2003. |
| Abundance Notes | Rivers: 1970-1989 index live spawner surveys expanded by stream miles. 1990-2002 stratified random sample (SRS) survey design. Pre-1990 calibrated to SRS estimates.<br>Lakes: index surveys expanded by historical mark-recapture data. |

**Southern Oregon/Northern California Coasts coho salmon ESU**

| | |
|---|---|
| Population | Rogue River |
| Years of Data, Length of Series | [see figure captions] |
| Abundance Type | Adult Fish |
| Abundance References | [See figure captions] |
| Abundance Notes | Abundance estimates based on expansion of beach seine abundance index based on hatchery fraction and returns of hatchery fish to Cole Rivers hatchery. |

| | |
|---|---|
| Populations | Hollow Tree Creek (Mendocino Co.) |
| Years of Data; Length of Series | 1986-2002 (1983 included for one site; 1992 excluded from one site); 16-18 years |
| Abundance Type | Juvenile density estimates (index reaches) |
| Data Sources | Electronic files provided Scott Harris, CDFG, based on data collected by Scott Harris and Wendy Jones (CDFG retired) |
| Abundance Notes | Juvenile density estimates are derived based on multiple-pass depletion estimates at index reaches established by CDFG. |

| | |
|---|---|
| Populations | South Fork Eel River basin (5 sites) (Mendocino Co.) |
| Years of Data; Length of Series | 1994-2002 for one site, 1995-2002 for all others; 8-9 years |
| Abundance Type | Juvenile density estimates (index reaches) |
| Data Sources | Electronic files provided David Wright and Stephen Levesque, Campbell Timberland Management, Fort Bragg, CA. |
| Abundance Notes | Juvenile density estimates are derived based on multiple-pass depletion estimates at index reaches established by Campbell Timberland Management. Most index reaches range from |

| | |
|---|---|
| | approximately 30 to 60 m in length. |

| | |
|---|---|
| Populations | Numerous throughout SONCC ESU |
| Years of Data; Length of Series | Variable, extending back to 1987. |
| Data Type | Presence-absence observations |
| Data Sources | Electronic database developed by NMFS SWFSC augmented with data provided by Bill Jong and Larry Preston, CDFG. |
| Data Notes | Database contains information on coho salmon occurrence in streams throughout the SONCC ESU. Original sources include a variety of surveys, reports, and other documents produced by CDFG, NMFS, tribes, private landowners, academic institutions, and others doing research or monitoring of coho salmon or other salmonids in streams believed to have historically supported coho salmon. Original sources are documented in databases housed at the NMFS SWFSC. |

**Central California Coast coho salmon ESU**

| | |
|---|---|
| Populations | Caspar Creek and Little River (Mendocino Co.) |
| Years of Data, Length of Series | 1987-2002; 16 years |
| Abundance Type | Smolt counts (partial) |
| Data Source | Electronic files provided Scott Harris, CDFG, based on data collected by Scott Harris and Wendy Jones (CDFG retired) |
| Abundance Notes | Smolt counts are partial counts made at downstream migrant traps and are not corrected for trap efficiency; numbers should be viewed as indices of abundance rather than population estimates |

| | |
|---|---|
| Population | Noyo River Egg Collecting Station (Mendocino Co.) |
| Years of Data, Length of Series | 1962-2001; 40 years |
| Abundance Type | Adult counts (partial) |
| Data Source | Grass 2002 |
| Abundance Notes | Counts of adult coho salmon are partial counts made at the Noyo Egg Collecting Station on the South Fork of the Noyo River. In most years, the trap was not operated continuously during the spawning season. Furthermore, trapping usually ceased when egg take goals were met. Thus, counts should be viewed as indices of abundance rather than population estimates |

| | |
|---|---|
| Populations | Pudding Creek, Caspar Creek, and Little River (Mendocino Co.) |
| Years of Data; Length of Series | Pudding Creek: 1983-2002 (except 1990); 19 years<br>Caspar Creek (2 sites): 1986-2002; 17 years<br>Little River (2 sites): 1986-2002 (except 2000); 16 years |
| Abundance Type | Juvenile density estimates (index reaches) |

| | |
|---|---|
| Data Sources | Electronic files provided Scott Harris, CDFG, based on data collected by Scott Harris and Wendy Jones (CDFG retired) |
| Abundance Notes | Juvenile density estimates are derived based on multiple-pass depletion estimates at index reaches established by CDFG. Pudding Creek site has been sampled in recent years by Campbell Timberland Management. |

| | |
|---|---|
| Populations | Noyo River, Big River, and Big Salmon Creek (Mendocino Co.) |
| Years of Data; Length of Series | Noyo River (8 sites): generally 1993-2002 (variable among sites); 6-10 years<br>Big River (2 sites): 1993-2002; 10 years<br>Big Salmon Creek (5 sites): generally 1993-2002 (variable among sites); 7-10 years |
| Abundance Type | Juvenile density estimates (index reaches) |
| Data Sources | Electronic files provided David Wright and Stephen Levesque, Campbell Timberland Management, Fort Bragg, CA. |
| Abundance Notes | Juvenile density estimates are derived based on multiple-pass depletion estimates at index reaches established by Campbell Timberland Management. Most index reaches range from approximately 30 to 60 m in length. |

| | |
|---|---|
| Populations | Lagunitas Creek (Marin Co.) |
| Years of Data; Length of Series | 1995-2001; 7 years |
| Abundance Type | Juvenile population estimates (expanded from index reaches) |
| Data Sources | Electronic files provided Eric Ettlinger, Marin Municipal Water District. |
| Abundance Notes | Juvenile density estimates for different habitat unit types are derived based on multiple-pass depletion estimates at index reaches. Unit-specific density estimates are then used in conjunction with habitat typing for the entire stream reach to obtain an overall population estimate for juveniles within the stream. |

| | |
|---|---|
| Population | Redwood Creek (Marin Co.) |
| Years of Data; Length of Series | 1994-2001 (excluding 1999); 7 years |
| Abundance Type | Juvenile population index |
| Data Sources | Smith 1994-2001. |
| Abundance Notes | Juvenile counts are made annually at multiple index sites in Redwood Creek using single-pass electrofishing. Mean numbers of fish per linear distance of stream were calculated based only on sites that were sampled each year during the period of record (i.e., sites sampled sporadically were not included in the overall estimate). |

| | |
|---|---|
| Populations | Waddell and Scott Creek (Santa Cruz Co.), and Gazos Creek (San Mateo Co.) |

| | |
|---|---|
| Years of Data; Length of Series | Waddell Creek and Scott Creek, 1992-2001; 10 years<br>Gazos Creek, 1993-2001 (excluding 1994); 8 years |
| Abundance Type | Juvenile population index |
| Data Sources | Smith 1992-2001. |
| Abundance Notes | Juvenile counts are made annually at multiple index sites in each creek using single-pass electrofishing. Mean numbers of fish per linear distance of stream were calculated based only on sites that were sampled each year during the period of record (i.e., sites sampled sporadically were not included in the overall estimate). |

| | |
|---|---|
| Populations | Numerous throughout Central California Coast ESU |
| Years of Data; Length of Series | Variable, extending back to 1987. |
| Data Type | Presence-absence observations |
| Data Sources | Electronic database developed by NMFS SWFSC augmented with data from the Russian River basin provided by Bob Coey, CDFG. |
| Data Notes | Database contains information on coho salmon occurrence in streams throughout the CCC ESU. Original sources include a variety of surveys, reports, and other documents produced by CDFG, NMFS, private landowners, water districts, academic institutions, and others doing research or monitoring of coho salmon or other salmonids in streams believed to have historically supported coho salmon. Original sources are documented in databases housed at the NMFS SWFSC. |

**Lower Columbia River coho salmon ESU**

| | |
|---|---|
| Population | Clatskanie River |
| Years of Data, Length of Series | 1949 - 2001, 53 years |
| Abundance Type | Fish per mile |
| Abundance References | Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J.. 1998; White, E., Morgan, B. and Fulop, J. 1999; Ollerenshaw, E. 2002. |
| Abundance Notes | Data from Streamnet |

| | |
|---|---|
| Population | Scappoose Creek |
| Years of Data, Length of Series | 1949 - 2001, 53 years |
| Abundance Type | Fish per mile |
| Abundance References | Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J.. 1998; White, E., Morgan, B. and Fulop, J. 1999; Ollerenshaw, E. 2002 |
| Abundance Notes | Data from Streamnet |

| | |
|---|---|
| Population | Big Creek |
| Years of Data, Length of Series | 1950 - 2001, 52 years |
| Abundance Type | Fish per mile |
| Abundance References | Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J. 1998; White, E., Morgan, B. and Fulop, J. 1999; Ollerenshaw, E. 2002. |
| Abundance Notes | Data from Streamnet |

| | |
|---|---|
| Population | Clackamas River |
| Years of Data, Length of Series | 1950 - 2001, 52 years |
| Abundance Type | Fish per mile |
| Abundance References | Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J. 1998; White, E., Morgan, B. and Fulop, J.. 1999; Ollerenshaw, E. 2002 |
| Abundance Notes | Data from Streamnet |

| | |
|---|---|
| Population | Youngs Bay |
| Years of Data, Length of Series | 1949 - 2001, 53 years |
| Abundance Type | Fish per mile |
| Abundance References | Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J. 1998; White, E., Morgan, B. and Fulop, J.. 1999; Ollerenshaw, E. 2002 |
| Abundance Notes | Data from Streamnet |

| | |
|---|---|
| Population | Sandy River (Marmot Dam) |
| Years of Data, Length of Series | 1977 - 2001, 25 years |
| Abundance Type | Dam count |
| Abundance References | Cramer 2002 |

| | |
|---|---|
| Population | Clackamas River (North Fork Dam) |
| Years of Data, Length of Series | 1957 - 2001, 45 years |
| Abundance Type | Dam count |
| Abundance References | Cramer 2002 |